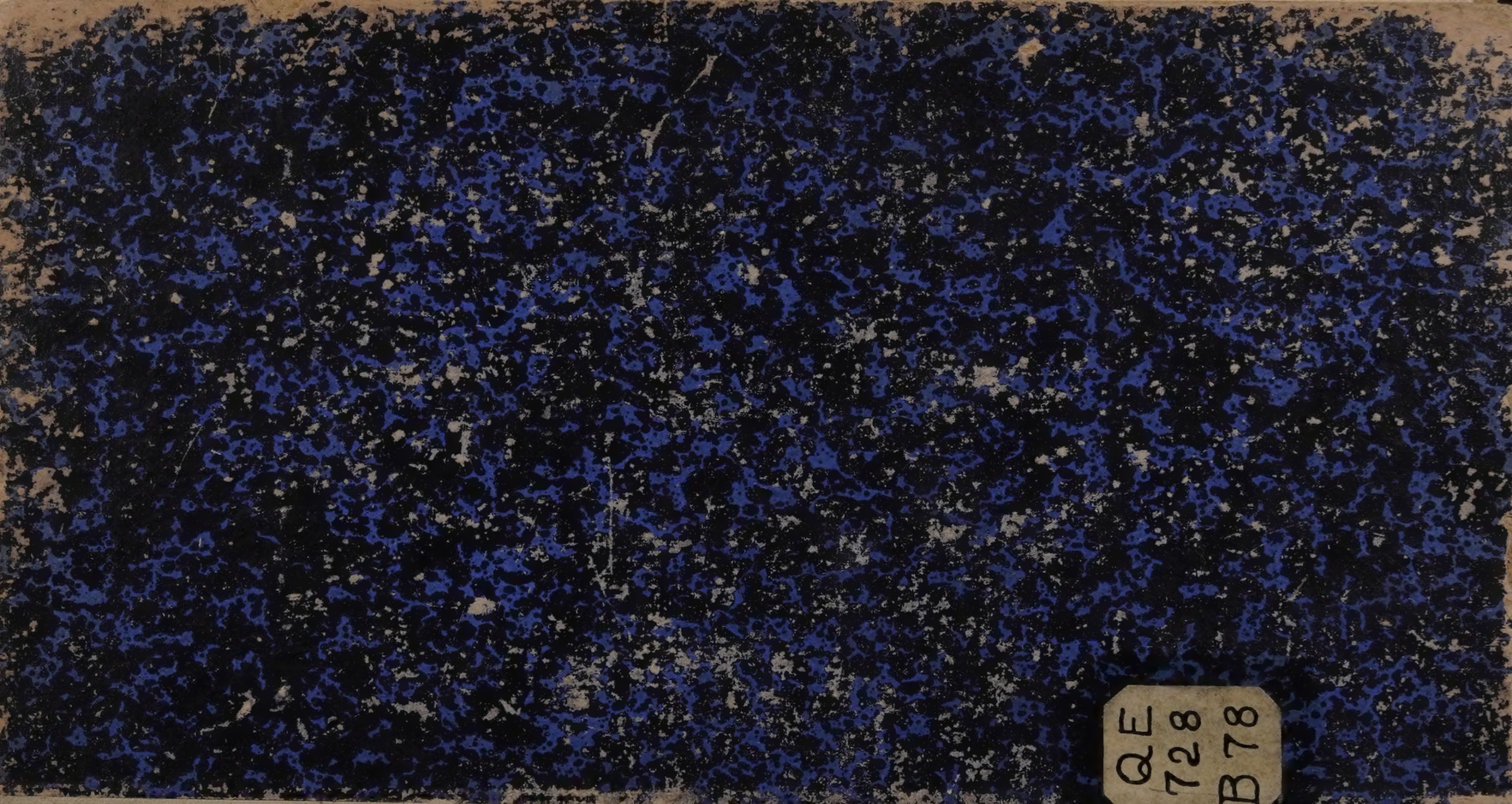

Bownocker The paleontology and stratigraphy of the corniferous rocks of Ohio

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THE PALEONTOLOGY AND STRATIGRAPHY OF THE CORNIFEROUS ROCKS OF OHIO.

BY J. A. BOWNOCKER.

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THE PALEONTOLOGY AND STRATIGRAPHY OF THE CORNIFEROUS ROCKS OF OHIO.

INTRODUCTORY NOTE.

In this paper the writer has followed Dana's classification of the Devonian rocks. This drops the term Upper Helderberg and uses in its stead Corniferous. On this basis the strata of the Corniferous period compose two epochs, the Schoharie and the Corniferous.

In classifying the faunas the writer has followed Eastman's edition of Zittel's Paleontology, as far as the uncompleted condition of the work would permit.

TIME RANK OF THE STRATA INVESTIGATED.

It is believed that the Schoharie epoch is absent in Ohio. The lithological characters which distinguish that epoch in New York are not present in Ohio, and the faunal characters in this state will not admit of division into two epochs. The Corniferous epoch only is recognized.

GEOGRAPHICAL LOCATION.

The territory in which this study was made embraces the three regions of Ohio in which Corniferous strata are found. The first of these is the central, extending from the southern part of Pickaway county north to the islands in Lake Erie. The second is the northwestern extending in a curve from the western part of Lucas county through Wood, Henry, Defiance, and Paulding counties into Indiana. The third is the western, and is a small outlier confined chiefly to Logan county.

AREA OF EACH REGION.

The central embraces by far the greater area. This is about 150 miles in length from its southern termination in Pickaway county north to Kelley's Island. Its average width is about 12 miles, the maximum 18 miles, and the minimum about 5 and one-half miles.

The northwestern area has a length of over 80 miles, an average width of perhaps 8 miles, a maximum of 13 miles, and a minimum of 3 miles.

The western area is roughly circular in shape. It is chiefly a narrow belt having a width usually of about 1 mile, but this increases in one locality to 6 miles.

STRATIGRAPHICAL RELATIONS.

The strata in the central part of the state may be divided into two horizons, (1) the Lower and (2) the Upper. The two horizons are separated by a persistent layer of fish remains a few inches in thickness and known as the bone-bed. The Lower beds are shown at every locality examined in central Ohio except Delaware and Sandusky. They are frequently called the Columbus beds. The Upper beds are found well developed at Delaware, Marion and Sandusky. Between Delaware and Columbus, in the observed exposures, this division is represented by shales only. It has not been found at all south of Columbus. The division is inconstant. Sometimes it is a formation of importance; at other times a few feet of shales only or, again, it may be absent altogether. These two divisions of the Corniferous differ in fauna, color, and chemical constitution.

The dip of the central division is to the southeast. At Columbus this is 30 feet per mile. Farther north the rate probably decreases as does that of the underlying formations. In some quarries the dip varies greatly. In Evans' quarry at Marion the beds in the two ends of the quarry dip in opposite directions, that is toward each other. A similar state is found at Kelley's Island. At White House the general dip is to the west, but there are many minor variations. In fact the expos-

ures suggest that the surface of the rock in that locality is gently undulating.

Below the corniferous lies the Lower Helderberg or Water Lime, a great series of beds having a maximum thickness of 600 feet. Above the Corniferous the Hamilton is doubtfully found. This is succeeded by the Ohio Shale which attains a thickness ranging from 250 to 3,000 feet.

CHEMICAL CONSTITUTION.

The formation is almost always limestone. The only exceptions are the thin intercalated layers of sandstone found at West Jefferson and a few other points, and the shaly layers lying above the bone-bed at Columbus and other places. These shales, however, are calcareous. The Upper or Delaware beds are less pure than the Lower beds, and contain more iron, alumina, and silica. The average may be taken at 75 % carbonate of lime and 25 % carbonate of magnesia. The magnesia increases as the underlying Lower Helderberg rocks are approached and decreases as the top of the formation is reached. Some of the lower beds contain as much as 35 % carbonate of magnesia, while the top layers may contain 2 % only. The carbonate of lime in the upper Columbus beds reaches 95 %, while in the highest layers at Kelley's Island it exceeds 97 %.[1]

Scattered through the beds are nodules of chert. These sometimes are almost wanting, as at Kelley's Island. At Columbus they form several irregular bands. In France's quarry, Bloomville, there is a series of beds aggregating 18 feet in thickness in which the chert composes 25 % (estimated) of the rock.

THICKNESS.

The maximum thickness of the Corniferous rocks of Ohio "so far as present records show, is between 75 and 100 feet."[2]

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[1] Edward Orton, Geol. Surv. of Ohio, Vol. VI, page 753.

[2] Geol. Surv. of Ohio, VII, page 18.

In the Taylor and Bell quarries near Marble Cliff the Lower or Columbus division is worked to a depth of 60 feet and at Delaware the Upper beds are worked to a depth of about 30 feet. The minimum thickness given by Prof. Orton is 25 feet. The thickness must vary considerably, owing to the partial or entire removal of the Upper or Delaware beds and also the partial removal of the Columbus beds. Other things being equal the greatest thickness should be found where the upper beds are well preserved, as at Delaware.

THE FAUNAS.

The faunas herein discussed were collected at the 12 following points, the location of which may be noted on the accompanying map. Pl. II.,—(1) Deer Creek, (2) Harrisburg, (3) Columbus, (4) Marble Cliff, (5) Dublin, (6) Delaware, (7) Radnor, (8) Marion, (9) Sandusky, (10) Kelley's Island, (11) White House, (12) Bellefontaine.

The faunas are rich and varied. Almost everywhere the strata contain abundant fossils. However, the Lower or Columbus beds are much superior in this respect. The faunas range from protozoans to vertebrates, though the *latter are not considered in this paper.* All branches of the animal kingdom have one or more representatives, *vermes* excepted. The coelenterata, mollusca, and molluscoidea especially are well represented.

In the discussion of the faunas the order from south to north will be followed, except in the case of Marble Cliff which will be considered first. The latter fauna has been collected with more care than any other, and hence will be used as a basis for comparison.

The Marble Cliff Faunas. These were collected in Price's quarry where the Columbus beds are worked to a depth of more than 30 feet. Above them the Delaware beds are represented by a maximum exposure of 12 feet of shales.

A section of the Lower horizon at this point is shown on Plate III. For convience the workmen's nomenclature is used. This in most cases is self-explanatory, but sometimes

the names are not significant. Collections were made here with a view of determining the vertical range of the species. On tabulating these, it was found that the most common specimens usually range throughout the entire series below the bone-bed, while the less common ones have a more restricted range. Further the species may be divided into three groups, one occupying the upper 10 feet and terminating with the "smooth rock"; the second occupying all below this, and the third ranging through both. These points are shown on the accompanying tables, Plates III and IV. The following lists show the species that are found in each horizon:

Top Beds. From bone-bed to 10 feet below.—Cladopora sp., Clathropora sp., Eridophyllum verneuilanum. E. & H., Eridophyllum simcoense. Bill, Heliophyllum halli. E. & H., Hadrophyllum d'orbignyi. E, & H., Zaphrentis gigantea. Leseur., Zaphrentis ovalis. H., Zaphrentis prolifica. Bill., Nucleocrinus verneuilanum. Troost., Codaster pyramidatus. Snum., Leptaena rhomboidalis. Wilch., Productella spinulicosta. H., Orthotetes chemungensis. Con., Spirifera acuminata. Con., Spirifera fimbriata. Mort., Spirifera gregaria. Clapp., Pentamerella arata. Con., Glyptodesma erecta. Con., Sanguinolites (?) sanduskyensis (?) H., Platyceras dumosum. Con.

Bottom Beds. Lying beneath Top Beds.—Stromatopora sp. Cystiphyllum americanum. E. & H., Rhipidomella livia. Bill., Stropheodonta concava. H., Stropheodonta demissa. H., Spirifera raricosta. Con., Modiomorpha perovata. M. & W., Paracyclas elliptica. H., Pterinea pinguis. H., Murchisonia desiderata. H., Isonema humilis. M., Callonemal ichas. H., Euomphalus decewi. Bill., Gomphoceras eximium. H., Gyroceras ohioensis, Phacops cristata. H.

Both Horizons. From bone-bed to bottom of quarry.—Favosites hemisphericus. Troost., Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes mucronatus. M. & H., Schizophoria propinqua. H., Stropheodonta hemispherica. H., Stropheodonta patersoni. H., Stropheodonta perplana. Con., Spirifera manni. H., Conocardium cuneus. Con., Dalmanites aspectans. Con.

These lists show that the brachiopods and corals are most abundant in the top beds, and that the blastoids are restricted to these beds; that the lamellibranchs are divided about equally between the two horizons; that the gastropods are nearly all found in the bottom beds, and that the cephalopods are restricted to this division.

By reference to the section on Plate III, it may be seen that three prominent faunal zones are located, the bone-bed, the reef-building coral, *Eridophyllum*, and *Spirifera acuminata*. These are all quite constant and have been traced across the state. Similar faunal zones are found above the bone-bed at Delaware and Marion, and will be further referred to when the faunas of those localities are reached.

The determined range of the fossils at Marble Cliff offers a means of correlating the faunas found at other localities and also of placing the strata in their proper place in the vertical scale, the latter point being shown by diagrams in Plate V.

The Deer Creek Fauna. This fauna was collected at the extreme southern limit of the Corniferous rocks of Ohio. It was obtained on the farm of B. Adkins, one mile S. W. of Deer Creek P. O. Formerly the rock was burned here in a small way for lime, and is reported to have been quarried to a depth of 10 feet. The rock which supplied the small kiln resembles that found at other points in central Ohio and is highly fossiliferous, but a few hundred yards up Deer Creek it is a "*bastard*" rock and is sparingly fossiliferous. The fauna named below was collected from small fragments of rocks lying around the old kiln. If a suitable exposure of the strata were had at this point, the fauna would, in all probability be much larger.

Anthozoa. Epidophyllum verneuilanum. E. & H., Favosites gothlandicus. Lam., Zaphrentis prolifica. Bill.

Brachiopoda. Atrypa reticularis. Linn., Chonetes mucronatus. M. & H., Nucleospira concinna. H., Rhipidomella livia. Bill., Schizophoria propinqua. H., Spirifera gregaria. Clapp., Spirifera manni. H., Spirifera ziczac. H., Stropheodonta patersoni. H., Stropheodonta perplana. Con., Stropheodonta sp.

Lamellibranchiata. Conocardium cuneus. Con.

Gastropoda. Bellerophon sp.

Crustacea. Proetus crassimarginatus. H.

The most abundant species is *Favosites gothlandicus.* The brachiopod *Spirifera gregaria* is interesting because of its unusual width. One individual was found having a width of 1 1-8 inches. Hall gives the maximum width of the species 7-8 of an inch. These forms also have less curvature of the ventral beak than other Ohio specimens. They have 10 ridges on each side of the fold and sinus. The unusual width and diminished gibbosity of these individuals give them an abnormal appearance.

The common species *Artypa aspera* and *Leptaena rhomboidalis* are here conspicuous by there absence, while *Spirifera zic-zac,* which is elsewhere uncommon beneath the bone-bed is rather plentiful.

The section evidently belongs a short distance below the bone-bed. This is best shown by *Eridophyllum verneuilanum.* None of the forms restricted to the lower part of the Marble Cliff section are found here.

HARRISBURG.

The stone is quarried at this place along the banks of Big Darby creek. The exposed section does not exceed 12 feet. The rock is burned for lime and is used for foundation purposes. It is worked on a small scale. The following species were collected:

Ahthozoa. Cyathophyllum corniculum. Cystiphyllum ohioense. Nich., Favosites emmonsii. Rom., Favosites turbinatus. Bill., Heliophyllum halli. E. & H., Michelinia cylindrica. Syringopora tabulata. E. & H., Zaphrentis compressa. Edw., Zaphrentis prolifica. Bill.

Brachiopoda. Amphigenia elongata. Van., Atrypa reticularis. Linn., Miristella nasuta. Con., Pentamerella arata. Con., Rhipidomella livia. Bill., Ryhnchonella tethys. Bill., Spirifera acuminata. Con., Spirifera fimbriata. Mort., Spirifera macrothyris. H., Spirifera manni. H., Spirifera varicosta. Con., Orthotetes chemungensis. Con., Stropheodonta ampla. H., Stro-

pheodonta concava, H., Stropheodonta demissa. Con., Stropheodonta hemispherica. H., Stropheodonta perplana. Con., Terebratula sullivanti. H.

Lamellibranchiata. Conocardium cuneus. Con., Modiomorpha concentrica (?) Con.

Gastropoda. Loxonema pexata. H., Murchisonia desiderata. H., Platyceras dumosum. Con.

The rock at this locality is the most fossiliferous of any of this age in the state. Often it becomes a true coquina. The fauna is quite different from that found at other points, not so much because of the different species found, but because of those that are here the common ones. These are almost without exception comparatively rare elsewhere. Further, the most characteristic species here vary from their normal forms, while two species that are usually common elsewhere, *Leptaena rhomboidalis* and *Atrypa aspera* have not been found at all.

The fauna is characterized by the presence of the two Spirifers, *S. macrothyris* and *S. manni.* The former is much larger than elsewhere in Ohio, having a width of more than 3 3-4 inches and a length of more than 2 5-8 inches. Twelve broad, flat ribs were counted on one side of the sinus. The forms are not as large however, as some that are figured in the New York reports. The species *S. manni* is wider than usual in proportion to its length, its area is lower and more curved, and its ribs more numerous. Fifteen of the latter were counted on one side of the sinus.

The coral, *Favosites emmonsii* is found here in large blocks and the brachiopod *Meristella nasuta* is more abundant than elsewhere.

Gastropods are rare and cephalopods absent.

The species *Michelinia cylindrica* and *Amphigenia elongata* are here reported for the first time in Ohio.

The presence of *Spirifera acuminata* and *Platyceras dumosum* indicates that the strata belong a short distance below the bone-bed. This is further shown by the absence of cephalopods and rarity of gastropods. The absence of *Eridophyllum ver-*

neuilanum puts the top of this section a little below the summit at Deer Creek P. O.

COLUMBUS.

Both divisions of the Ohio Devonian are found here, but the Delaware beds are represented by shales only. The fauna which is given below was collected entirely from beneath the bone-bed.

Spongia. Receptaculites devonicus. Whit., Stromatopora sp.

Anthozoa. Aulacophyllum sulcatum. D'Or., Cladopora sp., Cyathophyllum corniculum., Cyathophyllum halli., Cyathophyllum robustum. H., Cystiphyllum americanum. E. & H., Cystiphyllum ohioense. Nich., Eridophyllum verneuilanum. E. & H., Favosites gothlandicus. Lam., Favosites hemisphericus. Troost., Favosites turbinatus. Bill , Stylastrea anna. Whit., Zaphrentis compressa. Edw., Zaphrentis cornicula. Leseur., Zaphrentis prolifica. Bill.

Crinoidea. Dolatocrinus liratus. H., Megistocrinus spinulosis. Lyon.

Blastoidea. Codaster pyramidatus. Shum., Nucleocrinus verneuili. Troost.

Brachiopoda.. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes mucronatus. M & H., Chonetes sp. nov., Cyrtina hamiltonensis. H., Leptaena rhomboidalis. Wilck., Pentamerella arata. Con., Productella spinulicosta. H., Rhipidomella livia. Bill., Rhynchonella, carolina. H., Rhynchonella tethys. Bill., Schizophoria propinqua. H., Spirifera acuminata. Con., Spirifera fimbriata. Mor., Spirifera gregaria. Clapp., Spirifera maia. Bill., Spirifera manni. H., Orthotetes chemungensis. Con., Stropheodonta hemispherica. H., Stropheodonta inequiradiata (?) H., Stropheodonta perplana. Con.

Lamellibranchiata. Conocardium cuneus. Con., Paracyclas elliptica. H., Paracyclas lirata. Con., Pterinea pinguis. H., Sanguinolites (?) sanduskyensis (?) M.

Gastropoda. Callonema lichas. H., Euomphalus decewi. Bill., Loxonema pexata. H., Platyceras dumosum. Con., Platyceras multispinosum. M., Platyceras nodosum. Con.

Cephalopoda. Gomphoceras sciotoense. Whit., Gyroceras columbiense. Whit., Orthoceras ohioense.

Crustacea. Proetus crassimarginatus. H.

The formation at this locality is quite highly fossiliferous. The species found here and at Marble Cliff, which lies about three miles north, comprise the great body of the Corniferous forms of this state. However, these species are almost all found at other localities.

Immediately below the bone-bed is found a narrow faunal zone characterized by *Platyceras dumosum.* Below, but close to the above, is a well marked zone of *Spirifera acuminata.* About three feet below the bone-bed occurs a prominent zone of *Eridophyllum verneuilanum.* This attains a thickness of 2 feet.

It is interesting to note that *Leptaena rhomboidalis* and *Atrypa aspera,* both common species at most localities, have not been found south of this place, and that the same is true of the cephalopods.

Crinoids and blastoids are more common here than elsewhere in Ohio. About 100 codasters were picked up in Green Lawn Cemetery in a few hundred feet of red clay that had been stripped from the underlying rock.

This locality is perhaps the best in the state for collecting corals.

DUBLIN.

This is located about ten miles north of Marble Cliff. There are two quarries, one on each side of the river, but both are small. The rock is burned for lime on a small scale. The depth of the exposed sections was not determined with precision, but is probably not far from 25 feet. The following species were collected:

Spongia. Stromatopora sp.

Anthozoa. Favosites emmonsii. Rom., Favosites hemisphericus. Troost., Zaphrentis gigantea. Lesc ur., Zaphrentis prolifica. Bill.

Blastoidea. Codaster pyramidatis, Shum.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Cyrtina hamiltonensis. H., Rhipidomella livia. Bill.,

Schizophoria propinqua. H., Spirifera gregaria. Clapp., Spirifera macrothyris. H., Spirifera manni. H., Spirifera varicosa (?) H., Stropheodonta concava. H., Stropheodonta demissa. Con., Stropheodonta inequiradiata. H., Stropheodonta patersoni. H., Stropheodonta perplana. Con.

Lamellibranchiata. Conocardium cuneus. Con., Modiomorpha perovata. M & W., Mytilarca ponderosa. H., Paracyclas elliptica. H., Paracyclas lirata, Con., Pterinea pinguis. H., Sanguinolites (?) sanduskyensis (?) M.

Gastropoda. Bellerophon pelops. H., Euomphalus decewi. Bill., Loxonema pexata. H., Loxonema bellatulum. H., Callonema lichas. H., Pleurotomaria lucina. H., Turbo kearneyi., Turbo shumardi. Vern.

Cephalopoda. Gomphoceras sp., Gyroceras Columbiense. Whit., Orthoceras profundum (?) H.

Crustacea. Dalmanites bifidus. H., Dalmanites calypso. H., Dalmanites aspectans. Con., Phacops cristata. H.

This fauna is characterized by the abundance of lamellibranchs and gastropods and the comparative rarity of corals. The absence of the common species *Eridophyllum verneuilanum*, *Nucleocrinus verneuili*, *Leptaena rhomboidalis*, and *Spirifera acuminata*, all of which are found at Marble Cliff and Columbus a short distance below the bone-bed, indicates that the upper part of the Columbus division is absent, while the presence of many species found in the lower part of this division indicates that that portion of the Marble Cliff section is present. The abundance of gastropods denotes that the base of the Marble Cliff section is here well represented.

DELAWARE.

This fauna was collected from the higher of the two chief divisions of the Ohio Corniferous, and consequently lay above the bone-bed. Because of their dark blue color the strata make a striking contrast with the underlying division. The formation is thinner bedded than the one below. As the section on the Plate IV shows, several beds of impure shaly limestone are found. These with the dark color of the rock render

it unsuitable for lime, but it is a fine stone for building purposes, paving, and curbing.

The following fauna was collected in the Campbell quarry, adjacent to the C. H. V. & T. station :

Anthozoa. Cyathophyllum halli (?), Favosites sp., Hadrophyllum, d'orbignyi. E. & H.

Brachiopoda. Lingula manni. H.. Ambocoelia umbonata. Con., Chonetes yandelanus. H., Leiorhynchus limitaris. Van., Leptaena rhomboidalis. Wilck., Meristella nasuta. Con., Rhipidomella livia. Bill., Schizophoria propinqua. H., Spirifera acuminata. Con., Spirifera duodenaria (?) H., Spirifera ziczac. H., Stropheodonta hemispherica. H., Stropheodonta inequiradiata. H., Stropheodonta perplana (?) Con.

Lamellibranchiata. Aviculopecten parilis. Con., Glyptodesma erecta. Con., Grammysia bisulcata. Con.

Pteropoda. Tentaculites scalariformis. H.

Gastropoda. Platyceras bucculentum (?) H.

Cephalopoda. Gyroceras ohioense. N.

This fauna is small and manifestly different from that found at the localities already given, all of which lay below the bone-bed. Species that are found here for the first time in this study are *Lingula manni*, *Leiorhynchus limitaris*, *Grammysia bisulcata*, *Aviculopecten parilis*, *Tentaculites scalariformis*, and *Gryoceras ohioense*. Further, two of these species, *L. limitaris*, and *T. scalariformis*, are among the most common found. Worthy of note is *Spirifera ziczac*, which is rare below the bone-bed, but very abundant here.

Many of the common genera below the bone-bed are here absent,—*Aulacophyllum*, *Cystiphyllum*, *Eridophyllum*, *Zaphrentis*, *Conocardium*, *Paracyclas*, *Calloncma*, *Euomphalus*, *Loxoncma*, *Orthoceras*, *Proetus*, and *Phacops*.

Farther north at Marion and Sandusky several of these genera appear and the fauna more closely resembles that found below the bone-bed. There are several well marked faunal zones at this point. Those which have been definitely located are shown on the section, Plate IV These zones, as there shown, are composed of two or three species, and these it may

be added are by far the most abundant at this locality. Where the three species are found in one zone the brachiopods mingle together and just above or below the tentaculites occur. The latter usually lie on a film of shale, thus showing their shallow water habitat. Nearly always the species are found at the junction of two beds, but sometimes they lie in the middle of a stratum. This suggests that the changing conditions which separated the strata were most suitable for the life composing the zones.

Many of the best fossil fishes found in the Ohio Devonian came from this locality.

RADNOR.

This fauna was collected in the Meredith quarry where the rock is exposed to a depth of 12 feet. As the fauna shows, the section lies below the bone-bed. The rock closely resembles that found elsewhere at corresponding horizons. It is worked on a small scale. The following species were collected:

Spongia. Stromatopora mammillata. Nich., Stromatopora ponderosa. Nich., Stromatopora sp.

Anthozoa. Cyathophyllum corniculum., Favosites invaginatus. Nich., Favosites hemisphericus. Troost., Favosites turbinatus. Bill., Syringopora tabulata. E & H., Zaphrentis compressa. Edw., Zaphrentis gigantea. Leseur., Zaphrentis prolifica. Bill.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes mucronatus. H., Leptaena rhomboidalis. Wilck., Pentamerella arata, Con., Pholidostrophia narcea (?) H., Rhipidomella livia. Bill., Schizophoria propinqua. H., Spirifera acuminata. Con., Spirifera divaricata. H., Spirifera fimbriata. Mor., Spirifera gregaria. Clapp., Spirifera macrothyris. H., Spirifera manni. H., Orthotetes chemungensis. Con., Stropheodonta ampla. H., Stropheodonta concava. H., Stropheodonta demissa. Con., Stropheodonta hemispherica. H., Stropheodonta inequiradiata. H., Stropheodonta patersoni. H., Stropheodonta perplana. Con., Terebratula sullivanti. H.

Lamellibranchiata. Conocardium cuneus. Con., Modiomorpha concentrica (?) Con., Pterinea pinguis. H.

Gastropoda. Callonema lichas. H., Euomphalus decewi. Bill., Platyeras dumosum. Con., Trochus kearneyi. H., Turbo shumardi. Vern.

Crustacea. Dalmanites aspectans. Con., Dalmanites calypso. H., Proetus crassimarginatus. H.

This fauna closely resembles that found below the bone-bed at other points in central Ohio. The rock is highly fossiliferous, but the small scale on which it is worked does not afford good collecting ground. The species *Zaphrentis gigantea*, *Strophodonta ampla*, and *Spirifera divaricata* are more common here and in a better state of preservation than elswhere in Ohio.

The fauna includes species from both horizons below the bone-bed. Further, specimens found at Marble Cliff at the extremes of the section are present here, though the section is only 12 feet thick. This may be due to a shortening of the faunal section at this point, or, to a greater vertical range of the species whereby the extremes approach each other.

MARION.

The quarries adjacent to this city are the only ones visited by the writer where good sections comprising both divisions of Corniferous are found. The area which is small and is limited to a narrow ridge about one-half mile in length is situated a short distance northwest of the city limit. The southern corner of this ridge is crossed by the C. H. V. & T. railroad.

In the Morris and Christian quarry the strata below the bone-bed are exposed to a depth of 40 feet or more. The rock resembles that found elsewhere at corresponding horizons, but near the base is less compact, and perhaps more arenaceous. In the N. E. corner of this quarry the bone-bed is found. It is there covered by about 10 feet of strata, but to the west it soon reaches the surface.

In the Evans quarry, just across the railroad from the preceding quarry, the strata above the bone-bed are well shown. The bone-bed itself there lies about four feet above the railroad

switch tracks. Above this line the formation furnishes good building stone, but toward the summit, however, it becomes quite shaly and of course is worthless.

The following was furnished the writer as a representative section of the Corniferous in this vicinity by Mr. B. F. Waples, Supt. Morris & Christian Lime and Stone Company.

----*1′ ½ Cap rock, Shaly limestone.*

----*15′-18′. Blue limestone. Layers range in thickness from 3″-18″. Used for building purposes.*

----*Bone-bed.*

----*3′. Flinty limestone.*

----*12′-15′. Gray limestone. Used for fluxing.*

----*2′. Flinty limestone.*

----*25′. Gray limestone. Used for lime.*

The species which are found in the two horizons are given below:

	Above Bone-bed.	*Below Bone-bed.*
Spongia.		
Stromatopora sp.		x
Syringostroma columnaris. Nich.,		x
Anthozoa.		
Aulacophyllum sulcatum (?). D'Or.,		x
Cystiphyllum ohioense. Nich.,.	x	
Eridophyllum verneuilanum. E. & H.,		x
Favosites gothlandicus. Lam.,	x	
" hemisphericus. Troost.,	x	x
" turbinatus. Bill.,	x	x
Stylastrea anna. Whit.,		x
Syringopora tabulata. E. & H.,		x
Zaphrentis compressa (?). Edw.,		x
" cornicula. Leseur.,	x	
" prolifica. Bill.,	x	
Blastoidea.		
Nucleocrinus verneuili. Troost.,	x	
Brachiopoda.		
Atrypa aspera. Schloth.,	x	x
" reticularis. Linn.,	x	x
Chonetes mucronatus. M. & H.,	x	x
" yandellanus. H.,	x	
Leptaena rhomboidalis. Wilck.,	x	
Rhipidomella livia. Bill.,	x	x
Rhynchonella tethys. Bill.,		x
Schizophoria propinqua. H.,	x	x
Spirifera acuminata. Con.,		x
" duodenaria (?). H.,	x	
" fimbriata. Mor.,		x
" gregaria. Clapp.,		x
" maia. Bill.,	x	
" manni. H.,	x	
" varicosa. H.,		x
" ziczac. H.,	x	

	Above Bone-bed.	*Below Bone-bed.*
Orthotetes chemungensis. Con.,	x	x
Stropheodonta concava. H.,		x
" demissa. Con.,	x	x
" hemispherica. H.,	x	x
" perplana. Con.,	x	x
Terebratula sullivanti. H.,		x
" sp.	x	
Brachiopod. (undt.)	x	
Lamellibranchiata.		
Paracyclas lirata. Con.,	x	x
Conocardium cuneus. Con.,		x
Pteropoda.		
Tentaculites scalariformis. H.,	x	
Gastropoda.		
Platyceras dumosum. Con.,		x
" multispinosum. M.,		x
Cephalopoda.		
Gyroceras cyclops. H.		x
Crustacea.		
Phacops cristata. H.,		x

The fauna below the bone-bed is not so prolific as at the preceding localities. Gastropods and cephalopods are almost absent, while the lamellibranchs are represented by two species only. A good representation of corals is found, but brachiopods fall short of their southern representation. Atrypas and Stropheodontas are most common.

The fauna above the bone-bed closely resembles that at Delaware. The species which are most common at one locality are also the most abundant at the other. However, the faunas at the two localities are not identical, as a comparison of the species will show.

About two feet above the bone-bed at this point, the species *L. rhomboidalis* and *S. ziczac* are so abundant as to resemble a coquina. At Delaware there is a similar layer about 3 feet above the bottom of the quarry. If these two beds mark the same horizon, as the evidence indicates, the base of the Delaware quarries lies on or near the bone-bed. About 12 feet above the bone-bed is another zone of *S. ziczac* and *L. rhomboidalis*.

Near the summit of the strata at both Delaware and Marion lies a conspicuous bed of *Tentaculites scalariformis*. Often this shell is so abundant as to cover the surface of the rock.

SANDUSKY.

The formation found within or near this city belongs wholly above the bone-bed. The strata possess marked economic value, furnishing the city with high grade building stone. This retains the character which it possesses at Marion and Delaware. It is not usually worked to a depth exceeding 11 feet, and no observed exposures were found to a greater depth. According to the quarrymen it is not worked deeper because it becomes too thick bedded. This may mean that the beds just referred to belong below the bone-bed, for the layers found in this position are generally thick. Moreover no thick beds were found at any other localities above the bone-bed. The following species were collected:

Spongia. Stromatopora sp.

Anthozoa. Cyathophyllum halli., Cystiphyllum americanum. E. & H., Cystiphyllum ohioense. Nich., Favosites hemisphericus. Troost., Zaphrentis prolifica. Bill.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Athyris spiriferoides. Eaton., Chonetes mucronatus. M. & H., Chonetes yandellanus. H., Leptaena rhomboidalis. Wilck., Pentamerella arata. Con., Schizophoria propinqua. H., Spirifera acuminata. Con., Spirifera maia. Bill., Spirifera manni. H., Stropheodonta concava. H., Stropheodonta demissa. Con., Stropheodonta hemispherica. H., Stropheodonta perplana. Con.

Lamellibranchiata. Glyptodesma erecta. Con., Grammysia bisulcata. Con., Paracyclas lirata. Con.

Gastropoda. Callonema lichas. H., Platyceras attenuatum. H.

Pteropoda. Tentaculites scalariformis. H.

Cephalopoda. Gomphoceras eximium. H.

Crustacea Phacops cristata. H., Phacops rana. Green.

This fauna is the largest found above the bone bed in this State. The corals seem identical with those found below. The brachiopods are also quite similar. but *Athyris spiriferoides* and *Chonetes yandellanus* have not been found by the writer beneath the bone-bed. Among the lamellibranchs, *Grammysia bisulcata* and among the pteropods *Tentaculites scalariformis* are forms which have not been found positively below the bone-bed.

Two species which elsewhere are common above the bone-bed are rare or absent here. These are *L. rhomboidalis* and *S. ziczac.*

KELLEY'S ISLAND.

This island is composed of Corniferous rocks. The best exposures are in two quarries, one on the north side of the island and the other on the southwest. The maximum thickness of the exposed section is about 36 feet. Near the surface the rock is shaly, but it becomes thicker below, and near the bottom of the quarry a bed 10 feet thick is found. This stone is softer than that to the south. It is lighter in color, also, and freer from siliceous impurities.

The bone-bed has not yet been reported on the island and it is not yet certain that it exists there. Professor Orton thinks that the shales at the surface represent the Delaware or Sandusky horizon of the Corniferous.

The fauna is not conclusive on this point. The writer found a single specimen of *Tentaculites scalariformis*, but it was picked up in a pile of fragments and so is of undetermined location. Similarly *Spirifera ziczac* is found, but it appears to extend well down into the section. If this species here extends below the hypothetical line of junction of two great divisions of the Corniferous, why may not the former species do the same? To

the writer there is not satisfactory evidence to claim that the upper division is present. The formation is abundantly fossiliferous as the following list of species shows:

Rhizopoda. Saccammina eriana. Daw.

Spongia. Stromatopora mammillata. Nich., Stromatopora sp., Syringostroma columnaris. Nich.

Anthozoa. Cladopora sp., Cyathophyllum corniculum., Cystiphyllum americanum. E & H., Eridophyllum verneuilanum. E. & H., Favosites basalticus. Goldf., Favosites hemisphericus. Troost., Favosites pleurodictyoides. Nich., Favosites turbinatus. Bill., Syringopora tabulata. E & H., Stylastrea anna. Whit., Zaphrentis prolifica· Bill.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes acutiradiatus. H., Chonetes mucronatus. M & H., Leptaena rhomboidalis. Wilck., Nucleospira concinna. H., Orbiculoidea sp., Productella truncata. H., Rhynchonella tethys. Bill., Schizophoria propinqua. H., Spirifera acuminata. Con. Spirifera duodenaria. H., Spirifera manni. H., Spirifera zicz̧ac. H., Orthotetes chemungensis. Con., Stropheodonta concava. H., Stropheodonta demissa. Con., Stropheodonta crebristriata. Con., Stropheodonta hemispherica. H.,Stropheodonta inequiradiata. H., Stropheodonta patersoni. H., Stropheodonta perplana. Con., Terebratula sullivanti. H.

Lamellibranchiata. Aviculopecten sp. nov., Conocardium cuneus. Con., Modiomorpha concentrica (?) Con., Paracyclas elliptica. H., Paracyclas lirata. Con., Lamellibranch (Undt.)

Pteropoda. Tentaculites scalariformis. H.

Gastropoda. Bellerophon pelops. H., Callonema lichas. H., Euomphalus decewi. Bill., Loxonema pexata. H., Murchisonia desiderata. H., Platyceras carinatum. H., Platyceras dumosum. Con.

Cephalopoda. Gyroceras columbiense. Whit., Gyroceras cyclops. H., Gyroceras matheri (?) Con., Gyroceras ohioense. M., Gomphoceras eximium. H.

Crustacea. Dalmanites aspectans. Con., Dalmanites bifidus. H., Dalmanites calypso. H., Phacops rana. Green., Proetus crassimarginatus. H., Proetus planimarginatus. M.

The following are the principal features of the fauna:

1. Abundance of *Stropheodontas* of the species *perplana* and *hemispherica* and absence of *ampla*.

2. Rarity—almost absence of *L. rhomboidalis*.

3. Abundance of *S. acuminata*, and the comparative rarity of other *Spiriferas*.

4. Rarity of gastropods. Six genera were collected but the number of individuals of each was small, in some cases limited to a single specimen.

5. Abundance of cup corals of the form *Cyathophyllum corniculum*, and rarity of other cup corals.

6. The presence of *Favosites pleurodictyoides* which has not been found elsewhere in the state.

7. The abundance of *Saccammina eriana*.

8. The presence of *Productella truncata*, which is here reported for the first time in Ohio.

9. Absence or rarity of straight cephalopods. The coiled forms are not abundant.

As has already been stated the bone-bed has not been found here. It may be, however, as claimed by Dr. Orton, that the top beds belong above this line. There can be no doubt as to the strata extending at least close up to the bone-bed. This is proven by the presence of such species as *Spirifera acuminata*, *Platyceras dumosum*, and *Eridophyllum verneuilanum*, all of which are found to the south and a short distance below the bone-bed.

WHITE HOUSE.

In Pray's quarry just east of the village the stone is quarried to a depth of about 20 feet. The stone is thin bedded near the top, the layers being usually under ten inches in thickness. Farther down the strata become thicker, and near the bottom of the quarry one layer 28 inches in thickness is found. The upper part of the rock is quite free from chert, but the lower layers have much of it. The lower beds are less compact than the upper, and seem more arenaceous. Sometimes they resemble a sandstone in appearance. Above these layers the stone resembles more closely the ordinary limestone of this period.

The formation does not possess the high utility that it attains elswhere. It serves for foundations, abutments, curbings, etc. Formerly it was burned for lime but this has been discontinued.

The upper beds are by far the most fossiliferous. In this respect they are not excelled by any beds of this age in the state. The following species were collected:

Rhizopoda. Saccammina eriana. Daw.

Spongia. Stromatopora sp., Syringostroma densa. Nich.

Anthozoa. Aulacophyllum (?) sulcatum (?) D'Or., Favosites emmonsii. Rom., Favosites hemisphericus. Troost., Favosites invaginatus. Nich., Favosites limitaris. Rom., Favosites turbinatus. Bill., Stylastrea anna. Whit., Syringopora tabulata. E. & H., Zaphrentis prolifica. Bill.

Blastoidea. Nucleocrinus verneuili. Troost.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes mucronatus. M. & H., Chonetes yandellanus. H., Cyrtina hamiltonensis. H., Pentamerella arata. Con., Pholidostrophia nacrea. H., Productella spinulicosta. H., Productella truncata. H., Rhipidomella livia. Bill., Schizophoria propinqua. H., Spirifera divaricata. H., Spirifera euruteines. Owen., Spirifera gregaria. Clapp., Spirifera grieri. H., Spirifera macra. H., Spirifera macrothyris. H., Spirifera manni. H, Spirifera oweni. H., Spirifera ziczac. H., Stropheodonta concava. H., Stropheodonta demissa. Con., Stropheodonta hemispherica. H., Stropheodonta inequiradiata. H., Stropheodonta perplana. Con., Terebratula lincklaeni (?) H., Terebratula sp.

Lamellibranchiata. Conocardium cuneus. Con., Glyptodesma erecta. Con., Goniophora perangulata. H., Glosselettia (?) sp. nov., Modiomorpha concentrica. Con., Paracyclas elliptica. H., Paracyclas lirata. Con., Pterinea (?) flabella (?). Con., Schizodus sp. nov.

Pteropoda. Tentaculites scalariformis. H.

Gastropoda. Bellerophon pelops. H., Callonema lichas. H., Euomphalus decewi. Bill., Isonema humilais. M., Loxonema pexata. H., Murchisonia desiderata. H., Platyceras carinatum. H., Platyceras dumosum. Con.

Cephalopoda. Gomphoceras. sp., Orthoceras ohioense.

Crustacea. Dalmanites calypso. H., Phacops rana. Green., Proetus crassimarginatis. H., Proetus planimarginatus. M., Proetus rowi. (?).

The features of the fauna are the following:

1. Abundance of *Tentaculites.* These sometimes almost cover the surface of a stratum, and closely resemble the corresponding layer at Marion. They lie near the summit of the quarry.

2. Abundance of *Productella spinulicosta.* This is the only locality in Ohio known to the writer where this form is common.

3. Abundance of cephalopods of the *Gomphoceras* type. None are well preserved.

4. Abundance of specimens belonging to the genera *Paracyclas, Conocardium, Favosites, and Stropheodonta.*

5. Abundance of *Pholidostrophia nacrea.* This is absent or only doubtfully present in all sections previously reported on. It is often larger than the forms figured in the New York reports. One specimen was found which measured more than 1 1-8 inches along the posterior part, but of this more than 1-8 of an inch was occupied by the cardinal projections. Some times the cardinal extremities are mucronate, sometimes they are rounded. In the last case the hinge line does not represent the maximum width of the shell. Concentric lines of growth are conspicuous, but radiating striae are obscure or absent. The surface shows a nacreous luster, but the metallic hue sometimes seen on the New York form is not present here. The convexity of the ventral valve is usually considerably less than that figured in the New York reports. It is less than some Canadian forms also, with which a comparison has been made. None of the individuals show crenulations on the cardinal area, but the latter is rarely seen on specimens from any locality. The ventral valve only is found. A comparison of the muscular scars on the ventral valve with those figured in the New York reports shows a very close resemblance and leaves no doubt as to the correct identification of the specimens.

6. Absence or rarity of *Leptaena rhomboidalis*.

7. Presence in considerable numbers of *Stropheodonta demissa*, and the unusual size of these. This species, elsewhere in this state, has a width of 1 inch or more, but here it has a width of little more than ½ inch.

The formation and fauna at this place differ conspicuously from those of central Ohio. The rock resembles fairly well that found elsewhere below the bone-bed, but the blue-black stone so well shown at Delaware, Marion and Sandusky is not present here.

However, some of the most common White House species are found elsewhere above the bone-bed. These are *T. scalariformis* and *S. ziczac*. On the other hand, many forms common in the Columbus horizon are abundant here also. These include especially the genera *Stropheodonta*, *Favosites*, *Conocardium*, *Paracyclas*, *Atrypa*, *Isonema*, and *Platyceras*.

In other words, the two faunas of central Ohio appear to mingle in the upper part of the White House section, and hence the two fold division of strata and faunas made in central Ohio cannot be made at this point. However, the summit of this section must be placed at the top of the Ohio Corniferous—above the Delaware or Sandusky beds. It resembles the latter in such species as *T. scalariformis* and *S. ziczac*, both of which are abundant. That it is higher than those beds is shown by *Pholidostrophia nacrea* and *Productella spinulicosta*, both of which are here common, though in New York they are well known Hamilton species.

BELLEFONTAINE.

Several quarries are worked in or near this city, but what is said below refers to the two quarries situated about one-half mile northwest of the "Big 4" station. The rock is here quarried to a depth of about 25 feet. It resembles the light colored stone of this age found elsewhere in the State, but is less compact and has a more arenaceous appearance than any other, White House excepted. The stone is not worked extensively

at the present time. It is burned for lime, and is used for foundation purposes.

About 3 feet above the bottom of the quarry is an irregular band of chert a few inches in thickness. This is almost as white as chalk, and when wet is very soft, so that it works almost as easily as chalk. It is highly fossiliferous, as is shown by the fact that of the following species all but 6 came from this band:

Anthozoa. Zaphrentis prolifica. Bill.

Brachiopoda. Atrypa aspera. Schloth., Atrypa reticularis. Linn., Chonetes acutiradiatus. H., Chonetes mucronatus. M. & H., Crytina hamiltonensis. H., Orbiculoidea. sp., Pholidostrophia nacrea. H., Rhipidomella livia. Bill., Rhynchonella carolina. H., Rhynchonella tethys. Bill., Schizoporia propinqua. H., Spirifera acuminata. Con., Spirifera mucronata. (?), Spirifera oweni. (?) H., Stropheodonta hemispherica. H., Stropheodonta perplana. Con.

Lamellibranchiata. Conocardium cuneus. Con., Glyptodesma erecta. Con.

Gastropoda. Bellerophon pelops. H., Platyceras carinatum. H.

Crustacea. Proetus crassimarginatus. H.

The most characteristic fossil at this point is *Glyptodesma erecta.* It occurs in large numbers in the chert band already referred to, but is rare or absent elsewhere. It is found in larger numbers for corresponding thickness of stratum than any other lamellibranch in the Corniferous beds. The genera *Pholidostrophia* and *Orthis* are also common. Of the former the species *P. nacrea* is of special interest since the only other place in the state where it is common is White House. The form *S. perplana* is relatively more abundant here than elsewhere. Of the genus *Orthis*, the species *livia* is by far the most common. This is the only place found where this species is more abundant than *O. propinqua.* The form found is nearly always the dorsal valve, and is smaller than those which occur elsewhere. The *Spirifera* are of considerable interest. The species *S. acuminata* is found and with it a closely related form which has been referred doubt-

fully to *S. oweni.* It differs from the typical *S. acuminata* in having a length of hinge line that approaches the maximum width of the shell, a broader sinus, and ribs that are not dichotomous. However, it may belong to *S. acuminata,* but if so presents a strongly modified form.

Another point of interest is the rarity or absence of *Leptaenas* and the *Atrypas.*

The strata at this place are the most sparingly fossiliferous of any of this age in Ohio. The brachiopods are fairly well represented but that is the only group. Of the corals one species only is reported and the remaining great divisions present little better showing. Many of the most common forms elsewhere are here absent. The fauna is more closely related to that at White House than to any other. This is shown by the presence at both places of *P. nacrea, C. hamiltonensis* and *G. crecta.* These two places are the only ones where the first and last of these species are commonly found. Further evidence of a negative nature is furnished by the rarity or absence at both places of *Atrypas* and *Leptaenas.*

RELATION OF THE FAUNA ABOVE THE BONE-BED TO THAT BELOW.

As has already been stated the faunas above and below the bone-bed are fairly distinct. The difference, however, is not so great as at first appears; for more extensive collections show many species common to the two horizons. This point is well shown in the study of fossils from Delaware, Marion and Sandusky—all above the bone-bed. At Delaware the fauna is strikingly different from that below the bone-bed. This results from the presence of *Lingula manni, Chonetes yandellanus, Leiorhynchus limitaris, Spirifera ziczac, Aviculopecten parilis, Grammysia bisulcata, Tentaculites scalariformis, and Gyroceras ohioense;* also by the absence of genera common below the bone-bed, such as *Eridophyllum, Favosites* (rarely present), *Zaphrentis, Atrypa, Conocardium, Paracyclas, Callonema, Euomphalus, Dalmanites, and Proetus.*

Proceeding north from Delaware, we find at Marion more of the forms above the bone-bed, which to the south occur be-

low the bone-bed only. Here are found three common species of *Favosites*, two of *Zaphrentis*, two of *Atrypa*, three of *Stropheodonta* and one of *Paracyclas*. Moreover *L. manni* and *Leior. limitaris* are absent here. (See pp. 33-35.) This fauna manifestly more closely resembles that below the bone-bed than does that at Delaware. However, it retains *T. scalariformis* and *S. ziczac* in great numbers and these would be sufficient to place the fauna above the bone-bed.

Farther north yet the distinction becomes still less marked. At Sandusky are fouud *Stromatopora*, *Cyathophyllum halli*, two species of *Cystiphyllum*, one of *Zaphrentis*, two of *Atrypa*, four of *Stropheodonta*, one of *Paracyclas*, one of *Callonema* and two forms of *Phacops*. Moreover *S. ziczac* has not been found for certain at this place. However, *T. scalariformis* occurs, and is re-enforced by *A. spiriferoides*. This fauna resembles more closely that below the bone-bed.

The following shows the number of each class found at the three localities:

	Spongia.	*Anthozoa.*	*Blastoidea.*	*Brachiopoda.*	*Lamell.*	*Scaphopoda.*	*Gastropoda.*	*Cephalopoda.*	*Crustacea.*	*Total.*
Delaware	0	3	0	14	3	1	1	1	0	23
Marion	0	6	1	17	1	1	0	0	0	26
Sandusky	1	5	0	15	3	1	2	1	2	30

This shows that a greater number of species is found as one goes north. However, the Delaware formation is as fossiliferous as that at the other two cities named though the number of species is smaller.

The following species are found above the bone-bed and are not found below: Lingula manni, Chonetes yandellanus, Leiorhynchus limitaris., Athyris spiriferoides., Aviculopecten parilis, Grammysia bisulcata, Gyroceras ohioense, Tentaculites scalariformis.

Of these eight forms four have been found, one each, in one locality only, two in two localities, and four in four localities. (Pls. VI–VIII.)

It appears therefore, that the difference between the faunas above and below the bone-bed in the central Ohio area is not great, that this difference is most conspicuous at Delaware and diminishes to the north, being least at Sandusky.

ON THE CLASSIFICATION OF A FEW SPECIES.

Stylastrea anna. Forms referred to this species have been frequently found at nearly all localities from Columbus to Kelley's Island, also at White House. Various phases of preservation were to be seen. The specimens all agree in not having the septa run to the center.

Blocks containing a hundred polyps failed to show one in which the septa violated the rule just given. Moreover the septa are plainly denticulate. Tabula prominent. The forms in question agree very closely with Whitfield's description.[1]

This species is easily distinguished from *Acervularia* and *Cyathophyllum* by the septa which in these two genera reach the center.

Conocardium cuneus. This name has been adopted by the writer for what has commonly been known among Ohio Paleontologists as *C. trigonale.* Hall names the form in question *C. cuneus var. trigonale*, and states that this name is given to those forms found in the Corniferous limestone.[2]

A large number of specimens of this prolific form have been collected. Their comparison with Hall's plates of *C. cuneus* fails to show any difference on which a new species could be established, or even a new variety. The form of the species varies considerably, but these variations graduate into each other to such an extent that it does not seem advisable to divide the forms.

Dalmanites aspectans. To this species are referred the forms known as *D. helena. H.*, and *D. ohioense. M.* These names were applied to specimens shaped like the pygidium of *D. aspectans*, but differing from this species in having the surface

[1] Geol. Surv. of Ohio, Vol. VII, page 420, pl. II.

[2] Pal. N. Y., Vol. V, Pt. 1, Lamm. II, p. 410.

smooth. Some years ago, however, forms known as *D. ohioense* were found associated with *D. aspectans.*

Later, specimens were found which were only partially exfoliated. These show in some places characters of *D. aspectans*, and in others characters of *D. helena* or *D. ohioense.* Since *D. aspectans* was established first, this name must be retained for the forms under consideration.

SUMMARY.

This paper shows:

1. The species found in the Corniferous of Ohio, their distribution in the state, something as to their vertical range and variation.

2. That the life below the bone-bed comprises two faunas.

3. The relation between the faunas above and below the bone-bed and the variations found in the former.

4. It places the central Ohio sections in their proper vertical position.

5. That the White House fauna belongs higher in the Corniferous than any other fauna.

6. That the Bellefontaine fauna is more closely related to that at White House than to any other.

7. It gives some evidence bearing upon the classification of several common species.

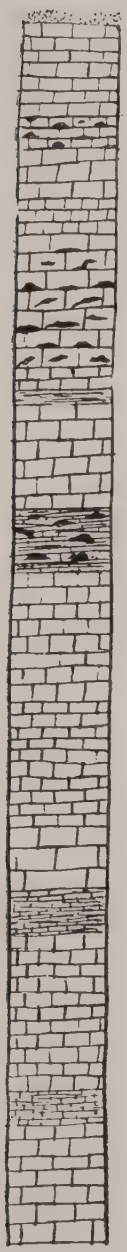
Geological Laboratory, Ohio State University, Nov., 1897.

BOWNOCKER—Corniferous Rocks of Ohio.

SHOWING THE VERTICAL RANGE OF THE CORNIFEROUS FAUNA AT MARBLE CLIFF.

	Bone-Bed.	Bastard Rock. 2' 8"	Gray Rock. 2' 10"	Blue Rock. 3'	Smooth Rock 18"	Top Calico. 12"	Bottom Calico. 7"	Curb Course. 20"	Sheepskin. 9"	Rough Rock. 16"	Ten and Six. 16"	Two Eights. 16"	Nineteen In. Course. 19"	Top Hackle. 14"	Bottom Hackle 13"	Twelve In. Course. 12"	Eleven In. Course. 11"	Two Foot Course. 2'	Two Foot Six. 2' 6"
SPONGIAE.																			
Stromatopora, sp			Zone of Eridophyllum	Zone of S. acuminata				x											
ANTHOZOA.																			
Aulacophyllum sulcatum, D'Or.					x														
Cyathophyllum, halli																			
Cystiphyllum americanum, E.& H.										x									
Eridophyllum verneuilanum, E & H			x																
Favosites hemisphericus, Goldf				x	x														
Hadrophyllum d'orbignyi, E. & H.	x																		
Heliophyllum halli, E. & H			x		x														
Zaphrentis cornicula, Les																			
" gigantea, Les.					x														
" prolifica, Bill.			x																
BLASTOIDEA.																			
Codaster pyramidatus, Shum.		x																	
Nucleocrinus verneuili, Troost			x		x ?														
BRACHIOPODA.																			
Atrypa aspera, Sch.				x	x					x	x						x		
" reticularis, Linn	x		x	x						x						x	x		
Chonetes mucronatus, M. & H					x					x	x					x			
" yandellanus, H.																			
Leptaena rhomboidalis, Wilck		x		x	x														
Productella spinulicosta, H.				x															
Rhipidomella livia, Bill										x									
Schizophoria propinqua, H				x	x					x	x					x			
Spirifera, acuminata, Con				x	x														
" fimbriata, Mor			x	x															
" gregaria, Clapp				x	x														
" manni, H		x	x ?							x						x			
" raricosta, Con										x							x		
Pentamerella arata, Con.				x															
Stropheodonta concava, H										x						x			
" demissa, Con										x									
" hemispherica, H.			x	x				x		x						x	x		
" patersoni, H.				x	x			x											
" perplana, Con.			x ?		x					x	x					x			
Orthotetes chemungensis, Con		x																	
LAMELLIBRANCHIATA.																			
Conocardium cuneus, Con					x					x						x			
Glyptodesma erecta, Con				x															
Modiomorpha perovata, M. & W.										x									
Paracyclas lirata, Con										x		x					x		
Pterinea pinguis, H											x								
Sanguinolites sanduskyensis, M.				x															
GASTROPODA																			
Callonema lichas, H.								x											
Euomphalus decewi, Bill																			
Isonema humilis, M.																	x		
Murchisonia desiderata, H.										x									
Platyceras dumosum, Con		x	x	x															
CEPHALOPADA.																			
Gomphoceras eximium, H.							x												
Gyroceras cyclops, H.							x												
Orthoceras ohioense								x		x									
CRUSTACEA.																			
Dalmanites aspectans, Con					x						x					x	x		
Phacops cristata, H.										x									

SECTION AT CAMPBELL'S QUARRY, DELAWARE.



8′ limestone.

----L. rhomboidalis, common.
18″ chert.
----L. rhomboidalis, very common.
18″ Limestone.
----Tentaculites on shaly surface.
14″ limestone.

39″ cherty limestone.

6″ limestone.

½″ shale.

20″ limestone.

10″ shales and chert.

----S. ziczac and L. rhomboidalis.

26″ limestone.

----S. ziczac L. rhomboidalis and T. scalariformis.

24″ limestone.

----S. ziczac and L. rhomboidalis, very common.
14″ limestone.

5″ shaly limestone.

----s. ziczac L. rhomboidalis T. scalariformis, abundant.
24″ limestone.

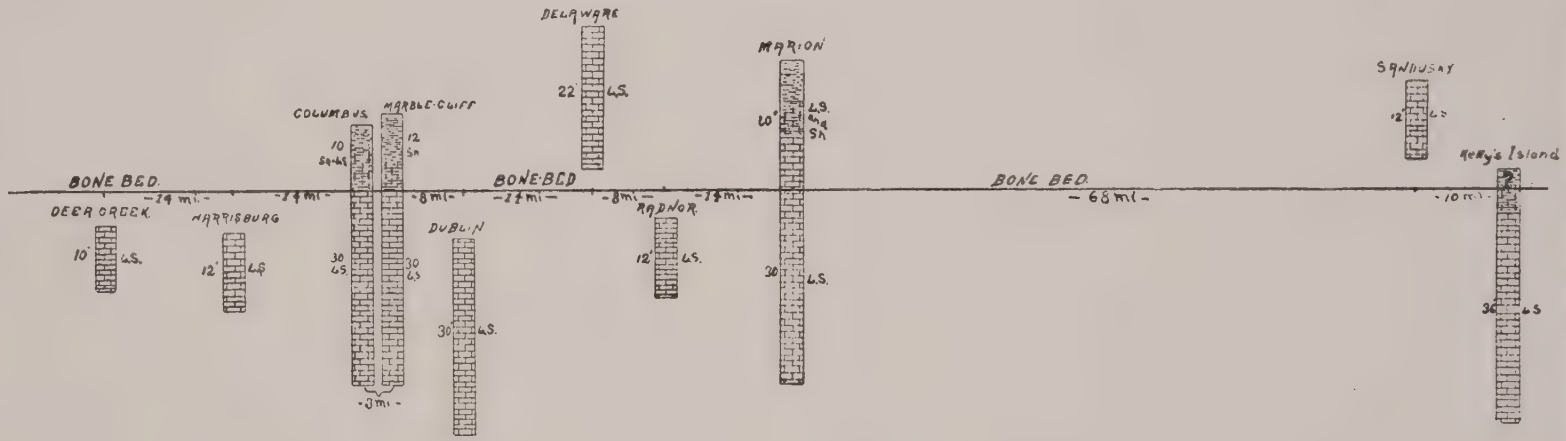
1½″ shaly limestone.

7″ limestone.

Bulletin, Denison University. Vol. XI, Art. II, 1898.

Showing the Position of the several Central Ohio Sections with reference to the Bone Bed —

ALL ON PALEONTOLOGICAL EVIDENCE



TABLES SHOWING THE GEOGRAPHICAL DISTRIBUTION IN OHIO OF THE CORNIFEROUS FAUNA.

	Deer Creek.	Harrisburg.	Columbus.	Marble Cliff	Dublin.	Delaware.	Marion	Sandusky	Kelley's Isl	White House	Belefontaine	Radnor.
RHIZOPODA.												
Saccammina eriana, D a w									x	x		
SPONGIAE.												
Receptaculites devonicus, Whit			x									
Stromatopora mammillata, Nich									x			x
" ponderosa, Nich												x
" sp			x	x	x		x	x	x	x		x
Syringostroma columnaris, Nich							?		x			
" densa, Nich										x		
ANTHOZOA.												
Aulacophyllum sulcatum, D'Or			x				?			?		
Aulopra sp												
Cladopora, sp		x	x						x			
Clathropora, sp				x								
Cyathophyllum, corniculum			x						x			x
" halli			x		?			x				
" robustum, H			x									
Cystiphyllum americanum, E & H			x	x				x	x			
" ohioense. Nich		x	x				x	x				
Eridophyllum verneuilanum, E & H	x		x	x			x		x			
Favosites basalticus, Goldf			x									
" emmonsi, Rom		x			x					x		
" gothlandicus, Lam	x		x				x					
" hemisphericus, Troost			x	x	x		x	x	x	x		x
" limitaris, Rom										x		x
" invaginatus Nich										x		x
" pleurodictyoides, Nich									x			
" turbinatus, Bill		x	x				x		x	x		x
" sp						x						
Hadrophyllum d'orbignyi, E. & H				x		x						
Heliophyllum halli, E. & H		x		x								
Michelinia cylindrica		x										
Stylastrea anna, Whit			x				x		x	x		
Syringopora tabulata, E. & H		x					x		x	x		x
Zaphrentis compressa, Edw		x	x				x					x
" cornicula, Les			x				x					
" gigantea, Les				x	x							x
" prolifica, Bill	x	x	x	x	x		x	x	x	x	x	x
CRINOIDEA.												
Dolatocrinus liratus, H			x									
Megistocrinus spinulosus, Lyon			x									
BLASTOIDEA.												
Codaster pyramidatus, Shum			x	x	x							
Nucleocrinus verneuili, Troost			x	x			x			x		
BRACHIOPODA.												
Ambocoelia umbonata, Con						x						
Amphigenia elongata, Van		x										
Athyris spiriferoides, Eaton								x				
Atrypa aspera, Sch			x	x	x		x	x	x	x	x	x
" reticularis, Linn	x	x	x	x	x		x	x	x	x	x	x
Chonetes acutiradiatus, H									x		x	
" mucronatus, M. & H	x		x	x			x	x	x	x	x	
" yandellanus, H						x	x	x		x		
" sp. nov			x									

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	Deer Creek.	Harrisburg.	Columbus.	Marble Cliff.	Dublin.	Delaware.	Marion.	Sandusky.	Kelley's Isl.	White House	Bellefontaine	Radnor.
BRACHIOPODA—Continued.												
Cyrtina hamiltonensis, H.			x	x						x	x	
Leiorhynchus limitaris, Van						x						
Leptaena rhomboidalis, Wilck			x	x		x	x	x	x			x
Lingula manni, M						x						
Meristella nasuta, Con		x				x						
Nucleospira concinna, H	x								x			
Orbiculoidea, sp									x			
" sp.											x	
Pentamerella arata, Con		x	x	x				x		x		x
Productella spinulicosta, H			x	x						x		
" truncata, H									x	x		
Rhipidomella livia Bill	x	x	x	x	x	x	x			x	x	x
Rhynchonella carolina, H			x								x	
" tethys, Bill		x	x				x		x		x	
Schizophoria propinqua, H	x		x	x	x	x	x	x	x	x	x	x
Spirifera, acuminata, Con		x	x	x		x	x	x	x		x	x
" divaricata, H										x		x
" duodenaria, H						x	x		x			
" euruteines, Owen										x		
" fimbriata, Mor		x	x	x			x					x
" gregaria, Clapp	x		x	x	x		x					x
" grieri, H										x		
" macrothyris, H		x			x					x		x
" macra, H										x		
" maia, Bill			x				x	x				
" mucronata?, Con											x	
" manni, H	x	x	x	x	x		x	x	x	x		x
" oweni ?, H										x	x	
" raricosta, Con		x		x								
" varicosa ? H					x		x					
" ziczac, H	x					x	x		x	x		
Orthotetes chemungensis, Con		x	x	x			x		x			x
Stropheodonta ampla, H		x							x			x
" crebristriata, Con			x						x			
" concava, H		x		x	x		x	x	x	x		x
" demissa, Con		x		x	x		x	x	x	x		x
" hemispherica, H		x	x	x		x	x	x	x	x	x	x
" inequiradiata, H			x		x	x			x	x		x
" nacrea, H										x	x	
" patersoni, H	x			x	x				x			
" perplana, Con	x	x	x	x		x	x	x	x	x	x	x
Terebratula lincklaeni ? H										x		
" sullivanti, H		x					x		x			x
" sp							x			x		
LAMELLIBRANCHIATA.												
Aviculopecten parilis, Con						x						
" sp. nov									x			
Conocardium cuneus, Con	x	x	x	x	x		x		x	x	x	x
Glyptodesma erecta, Con				x		x		x		x	x	
Goniophora perangulata, H										x		
Gosselettia ? sp. nov										x		
Grammysia bisulcata, Con						x		x				
Modiomorpha concentrica ? Con		x							x	x		x
" perovata, M. & W				x	x							

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LAMELLIBRANCHIATA—Continued												
Mytilarca ponderosa, H					x				x			
Paracyclas elliptica, H			x	x	x				x	x		
" lirata, Con			x		x		x	x	x	x		
Pterinea? flabella?, Con										x		
" pinguis, H			x	x	x							x
Sanguinolites sanduskyensis, M			x	x	x							
Schizodus sp nov										x		
PTEROPODA.												
Tentaculites scalariformis, H						x	x	x	x	x		
GASTROPODA												
Bellerophon pelops, H					x				x	x	x	
" sp	x											
Callonema lichas, H			x	x	x			x	x	x		x
Euomphalus decewi, Bill			x	x	x				x	x		x
Isonema humilis, M				x						x		
Loxonema pexata, H		x	x		x				x	x		
Murchisonia desiderata, H		x		x					x	x		
Platyceras attenuatum, H								x				
" bucculentum, H						x						
" carinatum, H									x	x	x	
" dumosum, Con		x	x	x			x		x	x		x
" multispinosum, M			x				x					
" nodosum, Con			x									
Pleurotomaria lucina, H					x							
Trochus kearneyi, H					x							x
Turbo shumardi, Vern					x							x
CEPHALOPADA.												
Gomphoceras eximium, H				x				x	x			
" sciotoense, Whit			x									
" sp					x					x		
Gyroceras columbiense, Whit			x		x				x			
" cyclops, H				x			x		x			x
" matheri? Con									x			
" ohioense, M						x			x			
Orthoceras ohioense			x	x								
" profundum, H					x							
CRUSTACEA.												
Dalmanites aspectans, Con				x	x				x			x
" bifidus, H					x				x			
" calypso, H					x				x	x		x
Phacops cristata H				x	x		x	x				
" rana, Green								x	x	x		
Proetus crassimarginatus, H	x		x						x	x	x	x
" planimarginatus, M									x	x		
" rowi? Green										x